
Research Interests

Physical & computational oceanography, Ocean mesoscale eddy parameterizations, Machine Learning, Scientific software development, Uncertainty quantification, Adjoint modeling, Ocean observing system design

Education

- 01/2015 - **University of Bergen**, Bergen, Norway.
- 08/2019 **Ph.D. in Physical Oceanography**
 - Thesis: *Adjoint Modeling and Observing System Design in the Subpolar North Atlantic*
 - Advisors: Kerim H. Nisancioglu (University of Bergen), Patrick Heimbach (UT Austin)
 - Funded by European Research Council project [ice2ice](#)
- 04/2007 - **University of Bonn**, Bonn, Germany.
- 02/2013 **Diploma** (equiv. M.Sc. degree) in **Mathematics, with Honors**
 - Specialization: Stochastic Analysis; Minor: Physics
 - Grade Point Average: 1.0, on a scale from 1.0 (excellent) to 4.0 (pass)

Research Experience

- 10/2022 - present **Postdoctoral Research Associate**, *Program in Atmospheric and Oceanic Sciences*, Princeton University.
 - Member of the [M2LInES project](#)
 - Apply machine learning methods to accelerate and improve ocean mesoscale eddy parameterizations
 - Mentors: Alistair Adcroft & Laure Zanna
- 10/2020 - 09/2022 **Postdoctoral Associate**, *Department of Applied Mathematics*, University of Colorado, Boulder.
 - Member of the [Ocean Transport and Eddy Energy Climate Process Team](#)
 - Improved ocean mesoscale eddy parameterizations via an energetically-consistent framework
 - Developed [open source software](#) for spatial filtering of gridded geophysical data
 - Mentor: Ian Grooms
- 09/2019 - 09/2020 **Postdoctoral Fellow**, *Oden Institute for Computational Engineering and Sciences*, University of Texas at Austin.
 - Leveraged adjoint modeling and uncertainty quantification for ocean observing system design
 - Mentor: Patrick Heimbach
- 1/2015 - 06/2018 **Graduate Researcher**, *Department of Earth Science*, University of Bergen, Norway.
 - Investigated oceanic teleconnections in the North Atlantic, Nordic Seas, and Arctic Ocean
 - Quantified uncertainties in ocean state estimates for present-day and paleo climates
- 03/2013 - 08/2014 **Doctoral Research Fellow**, *Department of Mathematics*, ETH Zurich, Switzerland.
 - Conducted research in the fields of Geometric Analysis and Partial Differential Equations
 - Assisted in teaching undergraduate and graduate level courses

Teaching and Outreach

- 08/2020 **Science Communication.**
 - Worked with Science Educator Annette deCharon to develop a [ArcGis Story Map](#) that explains adjoint modeling and a recent research article to a broader audience

- 02/2020 **Volunteer**, [Girl Day STEM Festival](#), UT Austin.
 - Hands-on science activities and demonstrations for elementary and middle school students
- 03/2013 - **Teaching Assistant**, *Department of Mathematics*, ETH Zurich, Switzerland.
- 08/2014 ◦ Taught 3 graduate level math courses (*Measure Theory & Integrals*, *Differential Geometry I, II*)
 - *Teaching evaluations*: 4.8 (2013), 4.9 (2014) on a scale from 1 (very bad) to 5 (excellent)
- 07/2013 **Teaching Assistant**, *PCMI Graduate Summer School*, Park City, UT.
 - Taught advanced math course (*Weak immersions of surfaces with L^2 -bounded second fundamental form*, [lecture notes](#)) for Ph.D. students and postdocs
- 10/2008 - **Teaching Assistant**, *Department of Mathematics*, University of Bonn, Germany.
- 02/2013 ◦ Taught 3 undergraduate level math courses (*Mathematics for Physicists I, Analysis II, III*)
- 01/2010 - **Teaching Assistant**, *Department of Mathematics*, University of Toronto, Canada.
- 04/2010 ◦ Taught undergraduate level math course (*Linear Algebra*)
- 2009 - 2011 **Student Assistant**, [Hausdorff Center for Mathematics](#), University of Bonn, Germany.
 - Organized and led math outreach events for students from elementary and secondary school

Funded Grants

- 08/2021- **NSF CSSI Grant**, *National Science Foundation*, \$166,590.
- 07/2025 ◦ Project: Collaborative Research: Frameworks: Convergence of Bayesian inverse methods and scientific machine learning in Earth system models through universal differentiable programming
 - Role: Principal Investigator (Lead PI: Patrick Heimbach, UT Austin)
- 02/2016 **Research Grant**, *Norwegian Research School in Climate Dynamics*, NOK 20,000.
 - for research stay at MIT

Awards and Scholarships

- 04/2019 **Rising Stars in Computational & Data Sciences**, *Oden Institute for Computational Engineering and Sciences*, University of Texas at Austin.
 - Selected for competitive, international career event for women in Computational & Data Sciences
- 03/2018 **Best Presentation Award**, *Research School on Changing Climates in the Coupled Earth System*, Sommarøy, Norway.
- 02/2013 **Award "Diploma with Honors"**, *Department of Mathematics*, University of Bonn, Germany, for graduating with highest possible grade point average.
- 2008 - 2012 **German Academic Scholarship Foundation Award**, [Studienstiftung des deutschen Volkes](#), for outstanding academic achievements (given to 0.5% of students in Germany).
- 2006 **3 Awards**, for exceptional results in high-school final exams on state-wide basis.
 - *Porsche AG*: for excellent performance in mathematics and physics
 - *German Physical Society*: for excellent performance in physics
 - *Reinhold Beitlich Foundation*: for exceptional overall performance

Mentoring

- 08/2022 Mentor for a coding project as part of [OceanHackWeek 2022](#)
- 06/2022 - Writing Mentor for an undergraduate student as part of the [SOARS program](#)
- 07/2022
- 10/2021 - Mentor for a CU Boulder undergraduate student as part of the [PROGRESS mentorship program](#)
- present

03/2022 - Mentor for 2 students as part of the [ASLOMP](#) mentorship program
present

Professional Service

Peer review service

Geophysical Research Letters, Journal of Advances in Modeling Earth Systems, Journal of Climate, Journal of Physical Oceanography, Journal of Open Source Software

Review of proposals

Panelist for reviewing NASA ROSES proposals

Organization of Conferences

08/2022 Co-Organizer of [OceanHackWeek 2022](#).

02/2022 Co-Convener for the session "Mesoscale Eddy Energy and Ocean Transport", Ocean Sciences Meeting 2022.

04/2017 Co-Convener for the session "Quaternary climate archives and proxy uncertainty", EGU General Assembly 2017.

09/2015 Co-Organizer of PhD conference "Connecting the ocean, atmosphere and ice sheets", 20 participants, Denmark.

Membership of Scientific Projects and Societies

09/2022 - Working group "NEMO working group on machine learning and model uncertainty"
present

Publications

Preprints

- P1 **N. Loose**, G.M. Marques, A. Adcroft, S. Bachman, S.M. Griffies, I. Grooms, R.W. Hallberg and M. Jansen. Parameterizing eddy form stress in a thickness-weighted average isopycnal ocean model, *submitted to Journal of Advances in Modeling Earth Systems*, [Preprint doi: 10.1002/essoar.10512867.1](#).

Journal Articles

- J7 **N. Loose**, S. Bachman, I. Grooms and M. Jansen. Diagnosing scale-dependent energy cycles in a high-resolution isopycnal ocean model, *Journal of Physical Oceanography*, [10.1175/JPO-D-22-0083.1](#), [Open-access preprint: 10.1002/essoar.10511055.2](#).
- J6 G. Marques, **N. Loose**, E. Yankovsky, J. Steinberg, C-Y Chang, N. Bhamidipati, A. Adcroft, B. Fox-Kemper, S. Griffies, R. Hallberg, M. Jansen, H. Khatri and L. Zanna. NeverWorld2: An idealized model hierarchy to investigate ocean mesoscale eddies across resolutions, *Geoscientific Model Development* 15, no. 17: 6567-79, [doi: 10.5194/gmd-15-6567-2022](#).
- J5 **N. Loose**, R. Abernathey, I. Grooms, J. Busecke, A.P. Guillaumin, E. Yankovsky, G. Marques, J.M. Steinberg, A.S. Ross, H. Khatri, S.D. Bachman, L. Zanna, P. Martin. GCM-Filters: A Python Package for Diffusion-based Spatial Filtering of Gridded Data, *Journal of Open Source Software*, 7(70), 3947, 2022. [doi: 10.21105/joss.03947](#).
- J4 I. Grooms, **N. Loose**, R. Abernathey, J.M. Steinberg, S.D. Bachman, G. Marques, A.P. Guillaumin, E. Yankovsky. Diffusion-Based Smoothers for Spatial Filtering of Gridded Geophysical Data, *Journal of Advances in Modeling Earth Systems*, 13, e2021MS002552, 2021. [doi: 10.1029/2021MS002552](#).

- J3 **N. Loose** and P. Heimbach. Leveraging Uncertainty Quantification to Design Ocean Climate Observing Systems, *Journal of Advances in Modeling Earth Systems*, 13, e2020MS002386, 2021. doi: [10.1029/2020MS002386](https://doi.org/10.1029/2020MS002386).
- J2 **N. Loose**, P. Heimbach, H. Pillar and K.H. Nisancioglu. Quantifying Dynamical Proxy Potential through Shared Adjustment Physics in the North Atlantic, *Journal of Geophysical Research: Oceans* 125, no. 9, 2020. doi: [10.1029/2020JC016112](https://doi.org/10.1029/2020JC016112). Selected as [Eos Research Spotlight](#).
- J1 Y. Fujii, E. Rémy, H. Zuo, P. Oke, G. Halliwell, F. Gasparin, M. Benkiran, **N. Loose**, J. Cummings, J. Xie, Y. Xue, S. Masuda, G.C. Smith, M. Balmaseda, C. Germaineaud, D.J. Lea, G. Larnicol, L. Bertino, A. Bonaduce, P. Brasseur, C. Donlon, P. Heimbach, Y. Kim, V. Kourafalou, P-Y. Le Traon, M. Martin, S. Paturi, B. Tranchant and N. Usui. Observing System Evaluation Based on Ocean Data Assimilation and Prediction Systems: On-Going Challenges and a Future Vision for Designing and Supporting Ocean Observational Networks, *Front. Mar. Sci.* 6:417, 2019. doi: [10.3389/fmars.2019.00417](https://doi.org/10.3389/fmars.2019.00417).
- Thesis
- T1 **N. Loose**. Adjoint Modeling and Observing System Design in the Subpolar North Atlantic, *Ph.D. Dissertation*, University of Bergen, 2019. <http://bora.uib.no/handle/1956/24456>.

Selected presentations

Invited Talks

- 07/2022 **M²LInES working group - Ocean Turbulence**, *Online*.
Extracting mesoscale eddy dynamics via spatial filtering: python tools and energy diagnostics
- 01/2022 **20th DRAKKAR Ocean Modelling Workshop (Invited Keynote Talk)**, *Online*.
Leveraging Uncertainty Quantification to Design Ocean Climate Observing Systems
- 12/2021 **Ocean Circulation and Climate Dynamics Colloquium, GEOMAR Kiel**, *Online*.
Oceanic teleconnections in the North Atlantic: From dynamical proxy potential to observing system design
- 06/2020 **IARPC Joint Modeling-Arctic Observing Systems Sub-Team Meeting**, *Online*.
Looking at observing systems through the lens of models: Targeted Observations
- 04/2018 **EGU General Assembly 2018 (solicited)**, *Vienna, Austria*.
How informative are SST proxy data in paleoceanographic inverse modeling?
- 03/2018 **Northumbria University**, *Newcastle, UK*.
Uncertainty Quantification and Constraints on Subsurface Heat Content at Greenland's Margins

Conference Talks

- 07/2022 **JuliaCon Minisymposium 2022: Differentiable Earth system models in Julia**, *Online*.
Adjoints for uncertainty quantification and observing system design
- 04/2022 **Ocean Sciences Meeting 2022**, *Online*.
Diagnosing scale-dependent Lorenz and Bleck energy cycles in a high-resolution layered model
- 01/2022 **12th Symposium on Advances in Modeling and Analysis Using Python, AMS Meeting**, *Online*.
GCM-Filters: A Python Package for Spatial Filtering Analysis of Gridded Data from Ocean and Climate Models ([slides](#))
- 02/2021 **2021 CESM Ocean Model Working Group Meeting**, *Online*.
Diagnosing and parameterizing the energy budget of ocean mesoscale eddies in an idealized model

- 02/2020 **Ocean Sciences Meeting 2020**, *San Diego, CA*.
The Dynamical Proxy Potential of the OSNAP Array
- 10/2018 **ECCO Meeting**, *Austin, TX*.
Comprehensive Observing System Design within the ECCO Framework
- 07/2018 **Workshop on Sensitivity Analysis and Data Assimilation in Meteorology and Oceanography**, *Aveiro, Portugal*.
Uncertainty Quantification as a Tool for Observing System Design - An Oceanographic Perspective
- 06/2018 **Adjoint (TACOMA) Workshop**, *Oxford, UK*.
Adjoints as a Tool for Observing System Design
- Conference Posters
- 06/2017 **Data Assimilation Workshop**, *Bergen, Norway*.
How Informative are Paleoceanographic Observations for an Inverse Problem?
- 05/2017 **Past Global Changes (PAGES) Workshop**, *Louvain-la-Neuve, Belgium*.
How Informative are Paleoceanographic Observations for an Inverse Problem?
- 03/2017 **Workshop on Emerging Applications of Data Assimilation in the Geosciences**, *Leiden, Netherlands*.
Uncertainty Quantification for Adjoint-Based Data Assimilation with Sparse Data

Field Work

- 07/2017 - **East Greenland Ice-Core Project (EastGRIP)**, *Greenland*.
08/2017 ○ Drilled shallow ice cores, conducted surface measurements and lab work in the science trench
- 08/2016 - **G.O. Sars**, *Irminger Sea*.
09/2016 ○ Collected physical oceanographic data and marine sediment cores for the [ice2ice](#) project (ERC)

Technical Strengths

- **Computer Languages:** Python (xarray, dask, numpy, scipy), MATLAB, Fortran, shell scripting
- **Software Contributions:** [GCM-Filters](#)
- **Visualization & Design:** Cartopy, Matplotlib, \LaTeX , HTML
- **Data & Databases:** NetCDF, Zarr
- **Platforms:** HPC, JupyterLab, GitHub